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BULLETIN

OF THE

TORREY BOTANICAL CLUB

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

OCTOBER, 1920

Phytogeographical notes on the Rocky Mountain region

IX. Wooded formations of the Montane Zone of the Southern Rockies

P. A. RYDBERG

The Montane or Canadian Zone extends in Central Colorado approximately between the altitudes of 2,500 and 3,000 m. In the upper part of the zone naturally many of the Subalpine plants are common and the lower part has been invaded by those of the foothills and plains. Many of these plants have been omitted in this discussion. As the Montane and Subalpine Zones are predominantly wooded, the plant associations are somewhat similar. In the open lands or grass-formations they are more unlike so far as the composition of the vegetation is concerned, the Montane being more like the plains and mesas of the Submontane Zone, and the Subalpine more like the Alpine Zone.

The principal forest trees of this zone are the following:—bull pine (*Pinus scopulorum*), lodge-pole pine (*P. Murrayana*), limber pine (*P. flexilis*), Douglas fir (*Pseudotsuga mucronata*), Engelmann spruce (*Picea Engelmannii*), Colorado blue spruce (*P. Parryana*), balsam fir (*Abies concolor*), narrow-leaved cottonwood (*Populus angustifolia*), balsam poplar (*P. balsamifera*), western black birch (*Betula fontinalis*), Rocky Mountain alder (*Alnus tenuifolia*), and smooth maple (*Acer glabrum*). These have been discussed in a previous paper.* To these may be added several species of willow, hawthorn, and chokecherry, which

* Bull. Torrey Club 42: 11–25. 1915.

[The BULLETIN for September (47: 367–440. *pl. 15–17*) was issued October 19, 1920.]

belong principally to the foothills. The following wooded formations may be distinguished, though elements of two or more are often mixed.

I. PINE FOREST

This consists mostly of a mixture of *Pinus scopulorum*, *Apinus flexilis* and *Pseudotsuga mucronata*. In some places, however, one or another of these species is predominant. This formation is limited mostly to the south slopes of the mountains, which are drier and hotter and where the soil is rather poor.

The last one of the three species mentioned seems to be more indifferent, however, to soil and moisture than the others, being found on the north as well as on the south slopes and associating with the pines as well as with the spruces, balsams, and aspens. To the three species are added in the northern part of the Southern Rockies the lodge-pole pine, *Pinus Murrayana*. In some places this forms pure stands, especially on burnt over areas, since it germinates readily and is quick in its growth.

Of the trees belonging to this formation, none is transcontinental or common to the Rockies and the Eastern Canadian Zone, three are common to the Rockies and the Pacific Highlands and one is endemic. Among the shrubs and herbs all four categories are found. As the transcontinentals and the eastern plants act much the same they will be treated together as an eastern element. Those marked "†" are found in the Southern Rockies only, not in the Northern. The nomenclature throughout follows the writer's "Flora of the Rocky Mountains and Adjacent Plains," New York, 1917.

1. TREES

a. Western

Pinus Murrayana
Apinus flexilis
Pseudotsuga mucronata

b. Endemic

Pinus scopulorum

2. SHRUBS

a. Eastern or transcontinental

Rubus pubescens
Lepargyraea canadensis

Chamaepericlimenum canadense
Arctostaphylos Uva-ursi
Viburnum pauciflorum
Linnaea americana

b. Western

Odostemon Aquifolium
Ribes viscosissimum
Pachystima Myrsinites
Ceanothus velutinus
Gaultheria humifusa
Arctostaphylos platyphylla†

c. Endemic

Ceanothus Fendleri†
Vaccinium oreophilum

3. HERBS

a. Eastern or transcontinental

Oryzopsis asperifolia
Cinna latifolia
Avena striata
Poa compressa
Streptopus amplexifolius
Coeloglossum bracteatum
Lysiella obtusata
Peramium ophioides
Peramium decipiens
Cytherea bulbosa
Corallorrhiza multiflora
Viola Selkirkii
Viola renifolia
Viola canadensis
Aralia nudicaulis
Moneses uniflora
Pyrola asarifolia
Pyrola elliptica
Pyrola chlorantha
Erxlebenia minor
Ramischia secunda
Monotropa uniflora
Veronica serpyllifolia
Botrychium Lunaria
Botrychium neglectum
Thelypteris Dryopteris
Pteris aquilina

b. Western

Oryzopsis Bloomeri
Poa Olneyae
Piperia unalaschensis
Ophrys nephrophylla
Atragene columbiana
Actaea arguta
Ozomelis stauropetala
Micranthes arguta
Osmorrhiza obtusa
Chimaphila occidentalis
Pyrola picta
Pterospora Andromedea
Razoumofskya americana
Razoumofskya Douglasii
Arnica cordifolia
Hieracium albiflorum

c. Endemic

Stipa Porteri†
Stipa Richardsonii
Calamagrostis Scribneri
Poa tricholepis†
Anticlea coloradensis†
Disporum trachycarpum
Trautvetteria media†
Atragene tenuiloba
Actaea viridiflora†
Ozomelis stenopetala†
Ozomelis Parryi†
Drymocallis fissa
Thermopsis pinetorum†
Thermopsis diversicarpa†
Atelophragma aboriginum
Atelophragma Macounii
Aragallus Richardsonii
Hedysarum boreale
Viola scopulorum
Osmorrhiza intermedia
Primula Parryi
Androsace pinetorum†
Pentstemon secundiflorus†
Pentstemon virens†
Erigeron superbus†
Anaphalis subalpina
Arnica pumila
Arnica sylvatica†
Notholaena Fendleri†
Selaginella Underwoodii†

II. SPRUCE FOREST

This is mostly confined to the north slopes of the mountains, which are much cooler and moister than the south slopes. As in the Subalpine Zone, the principal tree is the Englemann spruce, *Picea Engelmannii*. In some places this forms pure stands but usually it is mixed with the balsam fir, *Abies concolor*, the Colorado blue spruce, *Picea Parryana*, and the Douglas fir, *Pseudotsuga mucronata;* and, in the northern part, sometimes with the lodge-pole pine, *Pinus Murrayana*. The undergrowth is much the same as in the Pine Forest, and no attempt has been made to distinguish the undergrowth of the Pine Forest from that of the Spruce Forest.

III. ASPEN GROVES

These are found on richer more gentle slopes, both on the south and the north side of the mountains, but on the former only where there is a certain amount of moisture. The principal tree is the quaking aspen, *Populus tremuloides*, which I count as a transcontinental tree, as the western form, *P. aurea* Tidestrom, is so closely related to the eastern. The trees of the southern Rockies belong evidently to the latter, but in the Northern Rockies it is unknown where the range of one ends and that of the other begins. The vegetation consists mainly of the following plants:

1. TREES AND SHRUBS

a. Eastern and transcontinental

Populus tremuloides
Salix Bebbiana
Betula papyrifera
Rosa Bourgeauiana
Distegia involucrata

b. Western

Salix Scouleriana
Ribes viscosissimum
Rubacer parviflorum
Rubus melanolasius
Sorbus scopulina
Vaccinium scoparium

c. Endemic

Salix perrostrata
Edwinia americana†
Ribes coloradense†
Ribes Wolfii†
Opulaster glabratus†
Sericotheca microphylla†
Rosa Engelmannii
Rosa melina†
Rosa Woodsii
Sambucus microbotrys†
Sambucus melanocarpa

2. HERBS

a. Eastern and transcontinental

Phleum alpinum
Agrostis oreophila
Avena striata
Danthonia spicata
Poa crocata
Bromus Richardsonii
Agropyrum Richardsonii
Vagnera stellata
Ranunculus micranthus
Fragaria americana
Tium alpinum
Viola canadensis
Heracleum lanatum
Aralia nudicaulis
Pedicularis canadensis
Galium boreale
Erigeron droebachiensis
Botrychium simplex
Botrychium neglectum
Botrychium virginianum
Botrychium silaifolium
Polystichum Lonchitis

b. Western

Festuca subulata
Elymus glaucus
Veratrum speciosum
Vagnera amplexicaulis
Vagnera liliacea
Trillium ovatum
Thalictrum sparsiflorum
Aquilegia coerulea
Fragaria bracteata
Geranium viscosissimum

Geranium Richardsonii
Hypericum formosum†
Osmorrhiza obtusa
Glycosma occidentalis
Ligusticum tenuifolium
Pseudocymopterus sylvaticus
Conioselinum scopulorum
Polemonium occidentale
Collinsia parviflora
Pedicularis racemosa
Aster Geyeri
Erigeron macranthus
Erigeron speciosus
Erigeron conspicuus
Achillea lanulosa
Polypodium hesperium

c. Endemic

Stipa Scribneri†
Oryzopsis micrantha
Poa Vaseyana†
Poa longipedunculata
Festuca sororia†
Agropygron Richardsonii
Anticlea coloradensis†
Lilium montanum
Disporum trachycarpum
Alsine Curtisii
Silene Scouleri†
Silene Halliі†
Thalictrum venulosum
Thalictrum megacarpum
Thalictrum Fendleri†
Thalictrum stipitatum†
Viorna Scottii†
Viorna Jonesii
Atragene tenuiloba
Aquilegia elegantula†
Delphinium Barbeyi†
Aconitum columbianum
Sophia incisa
Sophia procera
Heuchera parviflora
Potentilla juncunda
Fragaria glauca
Drymocallis fissa
Sieversia grisea
Sieversia ciliata
Lupinus alpestris
Lupinus pulcherrimus
Lupinus humicola
Atelophragma Macounii
Homalobus oblongifolius†
Aragallus deflexus
Hedysarum marginatum†
Lathyrus laetevirens†
Lathyrus leucanthus†
Lathyrus arizonicus†
Ligusticum Porteri†
Ligusticum brevilobum†
Ligusticum affine
Harbouria trachypleura†
Pseudocymopterus montanus†
Pseudocymopterus tenuifolius†
Pseudocymopterus multifidus†
Conioselinum coloradense†
Polemonium delicatum†
Polemonium Archibaldae†
Polemonium molle†
Polemonium robustum†
Polemonium foliosissimum†
Mertensia ciliata†
Castilleja Crista-galli
Castilleja cognata†

Castilleja confusa
Castilleja rhexifolia
Castilleja trinervis
Pedicularis Parryi
Pedicularis crenulata†
Galium flaviflorum†
Oreochrysum Parryi†
Eucephalus wasatchensis†
Eucephalus glaucus†
Eucephalus formosus†
Aster adscendens
Erigeron yellowstonensis
Erigeron subtrinervis
Antennaria viscidula
Anaphalis subalpina
Helianthella Parryi†
Arnica macilenta†

IV. POPLAR GROVES

These are found in the narrower valleys and cañons, where there is a certain amount of moisture, but where the ground is comparatively well drained. The principal tree is the narrow-leaved poplar or cottonwood, *Populus angustifolia*. Another common tree is *Salix Scouleriana*, and Young* has called this formation the *Populus angustifolia—Salix Nuttallii* Formation.

Another common tree is the smooth maple, *Acer glabrum*. The balsam poplar, *Populus balsamifera*, has been collected in a few places in Colorado, and the canoe birch, *Betula papyrifera* (*B. Andrewsii*), has been collected in one cañon. Some of the evergreens have also partly invaded this formation, as *Pseudotsuga mucronata* and *Abies concolor*, and a few species of hawthorn are found in the lower part of the zone. In the Foothills (Submontane Zone) the narrow-leaved cottonwood is replaced mostly by *Populus acuminata* and *P. Sargentii*. The undershrub and herbaceous vegetation contains many species found in the Aspen Groves.

1. TREES AND SHRUBS

a. Eastern

Populus balsamifera
Salix Bebbiana
Betula papyrifera
Dasiphora fruticosa

b. Western

Pseudotsuga mucronata
Salix Scouleriana
Ribes viscosissimum
Cercocarpus ledifolius
Rubacer parviflorum
Rubus melanolasius

* Bot. Gaz. 44: 334–336. 1907.

c. Endemic

Populus angustifolia
Salix lutea
Salix padophylla
Salix perrostrata
Betula fontinalis
Edwinia americana†
Ribes coloradense†
Ribes Wolfii†
Opulaster monogynus†
Opulaster glabratus†
Sericotheca microphylla†
Rosa Engelmannii
Rosa melina
Rosa Woodsii
Sambucus microbotrys†
Sambucus melanocarpa
Sambucus neomexicana†

2. HERBS

a. Eastern or transcontinental

Torresia odorata
Phleum alpinum
Agrostis hyemalis
Calamagrostis canadensis
Dactylis glomerata
Poa crocata
Festuca rubra
Bromus ciliatus
Vagnera stellata
Chenopodium Botrys
Blitum capitatum
Claytonia virginica
Moeringia lateriflora
Moeringia macrophylla
Fragaria americana
Prunella vulgaris
Specularia perfoliata
Aster laevis
Erigeron droebachiensis
Filix fragilis

b. Western

Calamagrostis luxurians
Bromus polyanthus
Elymus glaucus
Ranunculus Douglasii
Ranunculus Bongardi
Aquilegia coerulea
Delphinum Nelsonii
Fragaria bracteata
Drymocallis corymbosa
Thermopsis montana
Lupinus tenellus
Geranium Richardsonii
Geranium viscosissimum
Glycosma occidentalis
Apocynum ambigens
Castilleja lancifolia
Erigeron macranthus
Aster Geyeri
Achillea lanulosa
Senecio pseudaureus

c. Endemic

Poa reflexa
Agropyron Richardsonii
Lilium montanum
Disporum trachycarpum

Chenopodium Fremontii
Silene Scouleri
Thalictrum megacarpum
Atragene tenuiloba
Ranunculus Earlei†
Delphinum robustum†
Delphinum elongatum
Delphinum ramosum†
Sophia leptophylla
Sophia incisa†
Sophia procera†
Fragaria glauca
Lupinus floribundus†
Lupinus parviflorus
Lupinus pulcherrimus
Lupinus humicola
Homalobus tenellus
Lathyrus brachycalyx†
Lathyrus leucanthus†
Lathyrus arizonicus†
Sidalcea candida†
Oxypolis Fendleri†
Apocynum scopulorum
Polemonium foliosissimum†
Hydrophyllum Fendleri†
Agastache pallidiflora†
Agastache urticifolia
Moldavica parviflora
Scrophularia occidentalis
Castilleja Crista-galli
Castilleja rhexifolia
Castilleja sulphurea
Pedicularis Grayi†
Galium flaviflorum†
Valeriana micrantha
Eucephalus glaucus†
Aster ciliomarginatus
Aster adscendens
Erigeron yellowstonensis
Erigeron superbus†
Helianthella quinquenervis
Anaphalis subalpina
Arnica subplumosa

V. ALDER–WILLOW SWAMPS

These are found in the wetter parts of the valleys, where the drainage is rather poor. They contain many of the species found in the preceding formation but also many belonging to the Sedge Bog. The most important woods belonging to the formation are the Rocky Mountain alder, *Alnus tenuifolia*, the western black birch, *Betula fontinalis*, and several species of willows. In the upper part of the zone, the formation becomes more and more like the willow bogs of the Subalpine Zone.*

1. TREES AND SHRUBS

a. Eastern

Salix chlorophylla
Salix cordata

* See Bull. Torrey Club 44: 449–450. 1917.

Betula glandulosa
Dasiphora fruticosa
Distegia involucrata

b. Western

Salix Scouleriana
Salix glaucops
Alnus tenuifolia
Kalmia microphylla

c. Endemic

Salix padophylla
Salix monticola
Salix Wolfii
Salix irrorata†
Salix perrostrata
Salix pachnophora†
Salix brachycarpa
Betula fontinalis
Svida instolonea
Negundo Kingii†
Sambucus microbotrys†
Sambucus melanocarpa
Sambucus neomexicana†

2. HERBS

a. Eastern and transcontinental

Calamagrostis canadensis
Panicularia nervata
Eleocharis palustris
Eleocharis acicularis
Streptopus amplexifolius
Alsine alpestris
Alsine crassifolia
Alsine borealis
Sisymbrium Nasturtium-aquaticum
Cardamine pennsylvanica
Geum rivale
Heracleum lanatum
Mimulus moschatus
Veronica americana
Elephantella groenlandica
Senecio pauciflorus
Nabalus racemosus
Equisetum arvense

b. Western

Poa leptocoma
Elymus glaucus
Veratrum speciosum
Limnorchis stricta
Limnorchis viridiflora
Limnorchis borealis
Thalictrum sparsiflorum
Ranunculus Douglasii
Ranunculus Bongardi
Trollius albiflorus
Parnassia fimbriata
Geum oregonense
Circaea pacifica
Mimulus Langsdorfii
Mimulus Lewisii
Pedicularis bracteosa
Galium subbiflorum
Senecio triangularis

Senecio pseudaureus *Athyrium cyclosorum*

c. Endemic

Poa reflexa
Panicularia pauciflora
Juncus truncatus
Allium brevistylum
Disporum trachycarpum
Limnorchis purpurascens†
Corallorrhiza ochroleuca
Corallorrhiza Vreelandii†
Rumex subalpinus†
Alsine Curtisii†
Thalictrum megacarpum
Thalictrum Fendleri†
Ranunculus Earlei†
Caltha rotundifolia†
Aconitum columbianum
Cardamine cordifolia†
Cardamine infausta†
Parnassia rivularis†
Geum decurrens†
Sidalcea candida†
Phymosia Crandallii†
Phymosia rivularis
Phymosia grandiflora†
Mertensia ciliata†
Scutellaria Brittoni†
Castilleja sulphurea
Pedicularis Grayii†
Galium flaviflorum†
Aster Canbyi†
Rudbeckia ampla
Senecio nephrophyllus†

VI. COPSES

Besides the shrubby willows included in the preceding formation, there are also shrubberries on dryer ground. These are found partly along the edges of the Aspen and Poplar Groves, the Willow Swamps and even the pinewoods, partly on dryer river-banks, and partly on the hillsides. Though the species of shrubs are not so many, the herbaceous flora associated with them is richer in species than that of either the woods or the meadows. In fact these copses contain many belonging to either and besides many of its own. Many of those belonging mainly to the woods or to the meadows are here omitted.

1. SHRUBS

a. Eastern

Dasiphora fruticosa

b. Western

Cerocarpus ledifolius
Rubacer parviflorum
Rubus melanolasius
Vaccinum scoparium

c. Endemic

Salix perrostrata
Salix brachycarpa
Atragene pseudoalpina†
Edwinia americana†
Edwinia macrocalyx†
Fendlera falcata†
Opulaster monogynus†
Opulaster alternans†
Chamaebatiaria Millefolium†
Sericotheca microphylla
Cercocarpus montanus
Oreobatus deliciosus†
Rosa melina†
Rosa aciculata†
Rosa manca†
Amelanchier oreophila†
Amelanchier Bakeri†
Amelanchier prunifolia†
Ceonothus velutinus
Vaccinium oreophilum

2. HERBS

a. Eastern

Panicum huachucae
Allium sibiricum
Vagnera stellata
Vagnera stellata
Bilderdykia Convolvulus
Moehringia latifolia
Moehringia macrophylla
Vicia trifida
Vicia americana
Xanthoxalis Bushii
Apocynum androsaemifolium
Clinopodium vulgare†
Pedicularis canadensis
Galium boreale
Specularia perfoliata

b. Western

Melica bella
Hesperochloa Kingii
Aquilegia coerulea
Lithophragma bulbifera
Lithophragma parviflora
Drymocallis corymbosa
Drymocallis glandulosa
Lupinus tenellus
Thermopsis montana
Linum Lewisii
Glycosma occidentalis
Apocynum ambigens
Gilia aggregata
Gilia pulchella
Hydrophyllum capitatum
Phacelia sericea
Lappula floribunda
Collinsia parviflora
Castilleja lancifolia
Erigeron macranthus
Balsamorrhiza sagittata
Achillea lanulosa
Artemisia Michauxiana

c. Endemic

Stipa Scribneri†
Orzyopsis micranatha
Poa reflexa
Poa rupicola
Agropyrum Richardsonii
Disporum trachycarpum
Lilium montanum
Polygonum Engelmannii
Silene Scouleri
Atragene pseudoalpina†
Capnoides Brandegei†
Sophia magna†
Sophia andrenarum
Sophia leptostylis†
Draba spectabilis†
Draba Hellerianа†
Hesperidanthus linarifolius†
Heuchera bracteata†
Heuchera Halliі†
Heuchera utahensis†
Heuchera parvifolia
Potentilla glaucophylla
Fragaria glauca
Lupinus floribundus†
Lupinus parviflorus
Tium scopulorum†
Homolobus decurrens†
Homolobus tenuifolius
Hedysarum utahense†
Lathyrus laetivirens
Lathyrus leucanthus†
Lathyrus arizonicus†
Viola montanensis
Ligusticum brevilobum†
Amarella heterosepala†
Amarella scopulorum
Dasystephana Parryi†
Phacelia ciliata
Dasystephana affinis
Dasystephana Forwoodii
Apocynum scopulorum
Polemonium albiflorum†
Hydrophyllum Fendleri†
Mertensia lanceolata
Agastache pallidiflora†
Agastache urticifolia
Moldavica parviflora
Scrophularia occidentalis
Penstemon strictus†
Penstemon unilateralis†
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Castilleja Crista-galli
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Valeriana micrantha
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Coleosanthus albicaulis†
Macronema obtusum†
Eucephalus glaucus
Aster subgriseus†
Aster ciliomarginatus
Aster adscendens
Erigeron incanescens†
Erigeron Smithii
Helianthella Parryi†
Senecio ambrosioides
Senecio multicapitatus†
Heteropleura Fendleri†
Agoseris agrestis†

VII. SAGEBRUSH

To the woody formations may also be added the Sagebrush lands. These are more characteristic of the Submontane Zone, but are also found in the Montane Zone above as well as in the Sonoran below. The most important shrub is *Artemisia tridentata*, which is found in all three zones. So also is *A. cana*, but the other sagebrushes are most common in the higher zones. As the sage lands are open formations, the undergrowth is mostly the same as in the dry valleys and on the tablelands. Only a few plants rather characteristic of this formation will be mentioned.

1. SHRUBS

Chrysathamnus filifolius
Artemisia cana
Artemisia tridentata
Artemisia nova
Artemisia tripartita

2. HERBS

Eriogonum cernuum
Penstemon cyathophorus
Penstemon xylus
Penstemon teuchrioides
Castilleja flava

NEW YORK BOTANICAL GARDEN

A method of preparation and some properties of a starch gel

CORNELIA LEE CAREY

Much of the work on starch has been on saccharification and very little on the colloidal properties, particularly those of the starch gel. Although starch in the gel condition does not exist in nature, it is interesting both from a colloidal chemical standpoint and also in relation to carbohydrate gels such as agar or cellulose.

It is difficult to prepare a starch gel which is stiff enough to be handled without breaking and crumbling, and it is almost impossible to make good gels of very high concentration, such as the one used here, by the usual procedure. It was with this idea in view that the following method was used. A 100 grams of commercial corn starch were well mixed with 150 c.c. of cold distilled water, and the mixture then poured into covered petri dishes. Enough starch solution was poured into each dish so that the bottom was just covered. A number of these dishes were then put in the autoclave for thirty minutes at a temperature ranging from 105° to 110° C. When still warm the starch was cut into strips. They were then put over the radiator to dry, later in the oven at 35° C., and finally dried in a desiccator over calcium chloride to constant weight. The starch prepared in this manner does not break on handling and when placed in water, at low temperatures, is only very slightly soluble. When completely dry it is somewhat transparent and tough. The transparency disappears again after standing in water for twenty four hours, but even after this it ir still fairly tough. Strips of this starch were weighed, put in 100 c.c. of distilled water and left for twenty-four hours at different temperatures. Surface water was removed by dipping the strips quickly into alcohol and ether and blotting on filter paper. They were then weighed to determine the amount of water adsorbed. In all cases the starch kept its shape and at low temperatures was hard and firm.

The water in which the starch strips had been standing turned

blue with iodine, but the amount of starch dissolved at low temperatures was not large. This increases as the temperature rises. Strips of the starch gel were placed in 100 c.c. of water and allowed to stand for twenty-four hours. An aliquot portion of the liquid was taken, evaporated and dried to constant weight in a desiccator. TABLE I gives the results, taken from only one determination in each case. In plotting the graph as indicated by the above figures it is apparent that there is a very sudden rise in the amount of the gel which passes into solution at 70° C. At the lower temperatures the correction would be negligible as is shown in TABLE II. The correction has been applied tentatively for the reason named above, since it would require more than one determination to determine it definitively. In any event it is obvious that the adsorption of water per gram starch gel would actually be even greater than as given in the tables at the end of this paper. It seems possible that the substance dissolved in the water does not do so immediately, but only on standing. No work, however, was done to determine this. The liquid at 90° C. and also those at lower temperatures gave no test for reducing sugars with Fehling's solution. At the higher temperatures the strips became larger and softer than at the lower but kept their shape.

TABLE I

	Temperature degrees Centigrade			
	35	70	80	90
Dry weight of strip in grams	2.064	0.800	0.679	0.664
Volume of water remaining after adsorption, cc.	97.768	97.432	97.634	97.402
Starch residue in 25 cc. of above water, in grams	0.001	0.006	0.016	0.030
Total weight of starch residue, in grams	0.039	0.024	0.061	0.117
Per cent weight of original strip dissolved	0.19	2.90	9.06	17.60

A microscopical view of a section of one of these starch strips showed that it did not have a homogeneous structure but was made of partially decomposed starch grains with a jelly-like substance between them which cements or holds them together. These partly swollen grains appeared unchanged even after boiling ten minutes in water. There may have been a slight increase in size, but no measurements were taken to determine this. It is the opinion of the writer that the starch grains only

partly swelled, at the temperature at which the gel was made, due to lack of water. It will be remembered that the gel was highly concentrated, $66^2/_3$ per cent, and it may be that swelling goes on forming a paste and leaving the grains only slightly changed, due to the insufficient supply of water present. A 10 per cent gel made by mixing starch and cold water and adding boi ing water to it contains empty sacs in the gelatinous mass. A 2 per cent gel after boiling five minutes showed these empty envelopes. These are probably the individual covers of the starch grains. Whether further disintegration takes place in the grains of the gel used in this work on standing in water at higher temperatures is not known, but investigation will be carried on along this phase of the problem.

Meyer (**5**), in his work on starch, observed these sacs. The early stages in swelling correspond to those seen in the gel used here. In this formation, according to him, the swelling continues until the sac is formed. In the beginning striations appear which disappear when the sacs become larger. Later the walls of the sacs wrinkle and when swelling is complete the walls of these collapsed sacs consist of a gel which is made of amicroscopic drops. Meyer also worked with corn starch. He prepared it by first mixing the starch with cold, and then with boiling, water. When the vessel containing the starch was placed in boiling water for five minutes all the grains were swollen and the sacs floated freely in the sol. The partly swollen grains, observed by the writer, appeared much as Meyer has described them. The contents were striated, the stripes running out from the center, and in the weaker gels the sacs seemed empty.

The gel is fairly resistant to heat. When newly made and while still hot, if boiled in water for fifteen minutes, only a small part went into solution. If the gel is allowed to set entirely, the amount dissolving becomes less. Gels fully dehydrated when boiled fifteen minutes kept their shape. They dissolved somewhat, however, as the liquid gave the characteristic blue color with iodine. If a 10 per cent sol, when still hot, (i.e. immediately after making) is put into boiling water, it dissolves. When the same gel is set and then boiled fifteen minutes only part of it goes into solution. It would appear from this that the setting of the sol is what makes

it partly irreversible at the temperature of boiling water. The higher the concentration of the sol the quicker the setting takes place, so that the starch used in this work was practically set when removed from the autoclave. This agrees with examples given by Meyer (**5**), showing that the setting of a sol at a certain temperature is more rapid the higher the concentration.

Maquenne and Roux (**3**, **4**) found that ordinary starch paste contained 80–90 per cent amylocellulose and the rest amylopectin. This they concluded from the results of iodine and saccharifying tests. They considered the geling properties of starch were due to the amylopectin. The amylocellulose was partly soluble in boiling water and completely liquified, according to Roux (**6**), in excess of water at 150° C. and had no geling power. At 90° C. 18 per cent of the gel goes into solution, according to the work of the writer. It may be that this is all amylopectin of Maquenne.

Taylor (**7**, p. 127) mentions the fact that starch sols are like silicic acid sols in their behavior, but does not state in what manner. The gel, however, seems to simulate more closely the elastic gels of agar and gelatine than the rigid one of silicic acid. Even these elastic gels have to be heated to a higher temperature than that at which gelation occurred before they will again become sols. The geling and melting points, in the case of gelatine, however, vary with the concentration and are also affected by organic substances and salts.

The general averages of the determinations given in the tables at the end of this paper, under APPENDIX, are shown in TABLE II, below. In the work carried on by the writer, with the range of temperatures used, the higher the temperature the more water was absorbed. Thus it is evident from the following figures there was no maximum point above which the adsorption decreased, at least up to 90° C. For at 8.5–10.5° C. the average adsorption is 0.864 grams water per gram dry starch, whereas at 90° C. it has risen to 3.713 grams of water, an increase of over four times that at about 8° C. As the temperature was raised the size of the strips increased upon swelling; they became softer and of a less tough and firm consistency. In some of the solutions at high temperatures there were minute shiny particles, the nature of which was not determined.

TABLE II

GENERAL AVERAGES FROM TABLES III–XI (SEE APPENDIX)

Temperature degrees Centigrade	Adsorption water per gram dry starch gel on basis of original weight	Adsorption water per gram, corrected according to TABLE I
8.5–10.5	0.864	correction negligible
17.5	0.896	" "
24	0.916	" "
35	1.140	1.142
50	2.426	2.448
60	2.807	2.865
70	3.153	3.274
80	3.427	3.768
90	3.713	4.411

In MacDougal's work with artificial biocolloid mixtures (1), mainly of agar but containing some protein, an increase in the total amount of swelling was found to a maximum point between 39° and 46° C. MacDougal (2) has also shown a greater swelling of agar than of gelatine in distilled water at the same temperature, and in mixtures of the two the swelling increased as the percentage of agar in the mixture was increased. From these results, and also from those shown in this paper, it would appear that at least carbohydrate gels behave somewhat similarly.

This increased adsorption with rise in temperature does not agree with Taylor (7, p. 155), who states that, according to LaChatelier's theorem, heat diminishes and cold and pressure increase imbibition. But Meyer (5) refers to the fact that gels dried in the air will swell again if put into water, the swelling being greater the higher the temperature of the water. The temperatures at which the writer's experiments were performed varied slightly from that taken as the average, but in no case was it enough to be noticeable in the amounts of water adsorbed.

The preparation of this starch gel was undertaken with the idea of obtaining a pure carbohydrate gel, which on account of its hydrative capacity would be suitable for experimentation under various conditions. In a sense it might be said to simulate a cellulose membrane, but it would be unsafe to carry the comparison too far. Inasmuch as the hydration of organic elastic gels is of fundamental importance in many physiological problems which are attracting great attention today, it has seemed worth while to place on record the results of the above experiments as a contribution to a partial knowledge of some of the properties which

this starch gel presents. The study of such systems becomes of interest, not only on account of the mere increase in size—the swelling which takes place on immersion in water with the implications that such phenomena have as regards growth phenomena—but also on account of its possible relation to problems of metabolism.

Since no chemical analyses were made (except those for reducing sugars in the water in which the strips had stood), the writer cannot say whether any changes took place in the starch due to the temperatures employed, either in the structure of the starch grains or chemically, but simply gives this method as a means of preparing a fairly resistant starch gel which is easily handled.

I wish to thank Dr. Herbert M. Richards for his valuable idea on the method and his helpful suggestions throughout the work, which are greatly appreciated.

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APPENDIX

TABLE III

WEIGHT OF WATER ADSORBED BY DRIED STARCH GEL IN GRAMS AT TEMPERATURE FROM 8.55 TO 10.5° C.

Original starch gel taken	After 24 hours in water	Gain	Water adsorbed per gram starch
1.320	2.552	1.232	0.933
1.073	1.937	0.864	0.805
1.107	2.045	0.938	0.847
1.552	2.821	1.269	0.817
1.484	2.743	1.259	0.848
0.932	1.709	0.777	0.833
0.970	1.809	0.839	0.864
1.067	1.984	0.917	0.859
0.741	1.462	0.721	0.973
0.897	1.667	0.770	0.858
			0.864

TABLE IV

WEIGHT OF WATER ADSORBED BY DRIED STARCH GEL IN GRAMS AT TEMPERATURE ABOUT 17.4° C.

Original starch gel taken	After 24 hours in water	Gain	Water adsorbed per gram starch
1.438	2.716	1.278	0.888
1.499	2.781	1.282	0.855
1.032	1.991	0.959	0.929
1.827	3.381	1.554	0.850
0.856	1.692	0.836	0.976
0.903	1.818	0.915	1.013
1.327	2.610	1.283	0.967
1.202	2.350	1.148	0.955
2.013	2.688	1.675	0.832
1.920	3.498	1.578	0.821
1.076	1.951	0.875	0.813
1.396	2.592	1.196	0.856
			0.896

TABLE V

WEIGHT OF WATER ADSORBED BY DRIED STARCH GEL IN GRAMS AT TEMPERATURE ABOUT 24° C.

Original starch gel taken	After 24 hours in water	Gain	Water adsorbed per gram starch
2.642	5.103	2.461	0.932
1.752	3.419	1.667	0.953
1.648	2.719	1.071	0.650
1.497	2.852	1.355	0.905
1.507	3.022	1.515	1.005
1.411	2.816	1.405	0.995
1.425	2.799	1.374	0.964
1.453	2.796	1.343	0.923
			0.916

TABLE VI

WEIGHT OF WATER ADSORBED BY DRIED STARCH GEL IN GRAMS AT TEMPERATURE ABOUT 35° C.

Original starch gel taken	After 24 hours in water	Gain	Water adsorbed per gram starch
1.716	3.680	1.964	1.144
1.531	3.300	1.769	1.155
1.825	3.930	2.102	1.149
1.580	3.306	1.726	1.092
1.564	3.230	1.666	1.065
2.064	4.296	2.232	1.081
1.759	3.843	2.084	1.184
2.001	4.169	2.168	1.081
1.161	2.605	1.444	1.243
1.216	2.686	1.470	1.208
			1.140

TABLE VII

WEIGHT OF WATER ADSORBED BY DRIED STARCH GEL IN GRAMS AT TEMPERATURE ABOUT 50° C.

Original starch gel taken	After 24 hours in water	Gain	Water adsorbed per gram starch
0.519	1.791	1.272	2.450
0.830	2.838	2.008	2.407
0.760	2.535	1.765	2.322
0.895	3.079	2.174	2.429
0.812	2.782	1.970	2.426
0.766	2.655	1.889	2.466
0.726	2.506	1.780	2.451
0.898	3.023	2.125	2.366
0.845	2.935	2.090	2.473
0.618	2.147	1.529	2.474
			2.426

TABLE VIII

WEIGHT OF WATER ADSORBED BY DRIED STARCH GEL IN GRAMS AT TEMPERATURE ABOUT 60° C.

Original starch gel taken	After 24 hours in water	Gain	Water adsorbed per gram starch
0.796	2.983	2.187	2.747
0.350	1.306	0.956	2.731
0.804	2.981	2.177	2.707
0.468	1.744	1.276	2.726
0.592	2.145	1.553	2.623
0.489	1.905	1.416	2.895
0.770	2.860	2.090	2.714
0.670	2.664	1.994	2.976
0.752	3.011	2.259	3.003
0.740	2.921	2.181	2.947
			2.807

TABLE IX

WEIGHT OF WATER ADSORBED BY DRIED STARCH GEL IN GRAMS AT TEMPERATURE ABOUT 70° C.

Original starch gel taken	After 24 hours in water	Gain	Water adsorbed per gram starch
0.468	1.944	1.476	3.154
0.402	1.610	1.208	3.004
0.644	2.622	1.978	3.071
0.513	2.105	1.692	3.298
0.637	2.613	1.976	3.102
0.433	1.866	1.433	3.307
0.809	3.377	2.568	3.171
0.800	3.368	2.568	3.210
0 921	3.785	2.864	3.109
0.595	2.446	1.851	3.107
			3.153

TABLE X

WEIGHT OF WATER ADSORBED BY DRIED STARCH GEL IN GRAMS AT TEMPERATURE ABOUT 80° C.

Original starch gel taken	After 24 hours in water	Gain	Water adsorbed per gram starch
0.656	2.693	2.037	3.105
0.519	2.246	1.727	3.327
0.674	3.056	2.382	3.534
0.968	4.375	3.407	3.519
0.729	3.146	2.417	3.315
0.700	3.058	2.358	3.368
0.600	2.810	2.210	3.683
0.975	4.232	3.257	3.340
0.598	2.748	2.150	3.595
0.679	3.045	2.366	3.484
			3.427

TABLE XI

WEIGHT OF WATER ADSORBED BY DRIED STARCH GEL IN GRAMS AT TEMPERATURE ABOUT 90° C.

Original starch gel taken	After 24 hours in water	Gain	Water adsorbed per gram starch
0.968	4.417	3.449	3.563
0.954	4.462	3.508	3.677
0.588	2.677	2.089	3.552
0.636	2.995	2.359	3.709
0.798	3.849	3.051	3.823
0.736	3.011	2.275	3.091
0.819	3.986	3.167	3.866
0.836	4.076	3.240	3.875
0.752	3.810	3.058	4.066
0.664	3.262	2.598	3.912
			3.713

New species of Uredineae—XII*

JOSEPH CHARLES ARTHUR

The preceding number in this series† was issued in April, 1919. Since that time the work of studying and assorting all of the remaining material in the rust herbarium, not heretofore assigned to acceptable genera and species, has proceeded with the result that a number of forms have been separated as worthy of recognition under distinctive names. These new species, founded for the most part on collections that have long reposed in various herbaria, together with two species that have been passing under erroneous names, are here established. A few species are transferred to other genera, and in three cases where the name was preoccupied new names have been given.

Melampsora americana sp. nov.

O. Pycnia hypophyllous, scattered among the aecia, broadly conic or hemispheric, yellowish or light-brown, rather inconspicuous, subcuticular but extending into and disintegrating the epidermal cells beneath, 80–150 μ broad by 50–90 μ high; ostiolar filaments wanting.

I. Aecia hypophyllous, scattered over part or all of the leaf on yellowish areas, oval or oblong, 0.3–0.8 mm. long, soon naked, pulverulent, at first orange-color, becoming pale-yellow, ruptured cuticle barely noticeable; aeciospores globoid or ellipsoid, 12–18 by 16–23 μ; wall colorless, 1.5–2.5 μ thick, closely and finely but noticeably verrucose.

II. Uredinia hypophyllous, irregularly scattered, usually on yellow spots, round, either very small, 0.1–0.2 mm. across, and pale, or large, 0.2–0.5 mm. across, pulvinate, orange fading to pale-yellow, ruptured epidermis inconspicuous; paraphyses capi-

* Reprints may be obtained by application to the Botanical Department, Purdue University Agricultural Experiment Station, Lafayette, Indiana, under whose auspices the studies here reported were largely carried out.

† New species of Uredineae I–XI: Bull. Torrey Club (I) **28**: 661–666. 1901; (II) **29**: 227–231. 1902; (III) **32**: 1–8. 1904; (IV) **33**: 27–32. 1906; (V) **33**: 513–522. 1906; (VI) **34**: 583–592. 1907; (VII) **37**: 569–580. 1910; (VIII) **38**: 369–378. 1911; (IX) **42**: 585–593. 1915; (X) **45**: 141–156. 1918; (XI) **46**: 107–125. 1919.

tate or clavate-capitate, 20–30 μ broad in upper part, 30–60 μ long, in strongly capitate forms the wall 4–5 μ thick, obliterating the lumen of the stalk, thicker at apex, 6–9 μ, in clavate forms the wall 1–2 μ thick, thicker above, 2–5 μ, colorless, smooth; urediniospores globoid or broadly ellipsoid, small, 13–16 by 15–20 μ; wall colorless, moderately thin, 1.5–2 μ, closely and finely verrucose.

III. Telia hypophyllous, scattered, irregularly roundish, 0.2–0.4 mm. across, reddish-brown, subepidermal, indehiscent, teliospores oblong or prismatic, rounded at both ends, 7–12 by 30–32 μ; wall light-brown, uniformly thin, about 1 μ, smooth.

On *Abies balsamea* (L.) Mill., Pictou, Nova Scotia, June 24, 1910, *W. P. Fraser;* Brule, Wisconsin, June-July, 1913, *E. M. Gilbert;* Fish Creek [Green Bay peninsula], Wisconsin, July 4, 1913, *J. J. Davis;* Alpena, Michigan, June 20, 1914, *C. H. Kauffman;* Walden, Vermont, July 8, 1917, *C. R. Orton.*

On *Abies concolor* Lindl. & Gord., Ouray, Colorado, July 26, 1912, *J. C. Arthur 8504* (Barth. Fungi Columb. *3819*); Palmer Lake, Colorado, July 3, 18, 1913, & July 15, 1916, *E. Bethel.*

On *Salix balsamifera* Barr., Pictou, Nova Scotia (near caeoma on *Abies*), August 27, 1910, II, III, *W. P. Fraser.*

Salix discolor Muhl., Pictou, Nova Scotia, July 17, 1910, II, November (?), 1910 III, *W. P. Fraser* (type, partly used for cultures); Orient, New York, September 7, 1914, II, September 28, 1919, II, *Roy Latham.*

Salix humilis Marsh., Orient, New York, September 19, 1915, II, III, *Roy Latham 647.*

On *Salix monticola* Bebb, Palmer Lake, Colorado, September 6, 1913, II. *E. Bethel.*

On *Salix pedicellaris* Pursh, Solon Springs, Wisconsin, August 13, 1915, II, III, *J. J. Davis.*

On *Salix Scouleriana* Barr., Libby, Montana, October 15, 1911, ii, III, *James R. Weir;* Ouray, Colorado, July 24, 1912, II, *Mrs. J. C. Arthur 4307;* Palmer Lake, Colorado, September 6, 1913, II, iii, *E. Bethel,* September 20, 1913, II, III, *Bartholomew & Bethel 5669.*

On *Salix Wrightii* And., Brazito, New Mexico, November 1, 1915, ii, III, *W. A. Archer 25.*

This is a common and abundant species, extending practically throughout the United States and southern Canada, and probably

southward through Mexico and Central America. It has heretofore passed under the name of *Melampsora arctica*. The type selected for the species is the collection on *Salix discolor* Muhl., made by W. P. Fraser at Pictou, Nova Scotia, November (?), 1910, and partly used for successful cultures in May, 1911, on *Abies balsamea*, which were reported in Mycologia (4: 187–188. July, 1912).

The first aecia of this species seen by the writer were forwarded by Professor Fraser in 1910. Word was returned that they were an undescribed form, probably belonging to *Melampsora arctica* on *Salix*. Telial material on *Salix* was secured by Professor Fraser in the fall, and sown on *Abies balsamea* in May, 1911, with abundant success (*cf.* Mycologia *l.c.*). Representative specimens were sent to the writer, and these now constitute the type material for the new species. A similar culture was made in June, 1912 (*cf.* Mycologia 5: 238. 1913).

An entirely independent set of observations and cultures was made by Mr. E. Bethel in Colorado. He obtained aecia on *Abies concolor* at Palmer Lake, Colorado, July 15, 1916, and on the following morning made sowings in his garden at Denver, on three species of willow. Eighteen days afterward, August 3, an abundance of uredinia was found on two plants, one probably *Salix Bebbiana*, and the other probably *S. Scouleriana*, but on two other equally vigorous plants of *S. amygdaloides* there was no indication of infection. Representative specimens with notes are in the Arthur herbariun.

All the aecial collections known to the writer, with the exception of one uncertain specimen from the state of Washington, are mentioned above, and most of the telial collections. But some forty collections believed to belong here, mostly with uredinia only, are not listed. The unlisted specimens include the hosts: *Salix cordata* Muhl., *S. exigua* Nutt., *S. Fendleriana* And., *S. lasiolepis* Benth., *S. lutea* Nutt., *S. Mackenziana* Barr., *S. Nelsoni* Ball, *S. sitchensis* Sans., *S. taxifolia* H. B. K., as well as the cultivated forms, *S. alba* L., *S. babylonica* L., *S. Caprea* L., and *S. purpurea* L. These collections come from the following states in addition to those mentioned above: Alaska, Arizona, California,

Idaho, Oregon, Washington, West Virginia, Virginia; Alberta, British Columbia; Guatemala.

I am indebted to Mr. Ivar Jorstad, plant pathologist to the government of Norway, for calling my attention to the misapplication of the name *Melampsora arctica*. While in this country in 1919–20 he paid two visits to Purdue University, and made most helpful suggestions regarding the synonymy and limitation of a number of species to appear soon in the North American Flora. He pointed out that no rust was known in Europe corresponding to the American caeoma on *Abies*.

Mr. Jorstad further directed attention to the essential identity of *Melampsora alpina* Juel and *M. arctica* Rostr., as given in the 7th volume of the North American Flora, pp. 99, 100, and as confirmed by his own studies. In Greenland, where Rostrup's material was obtained, various species of *Saxifraga*, on which the aecia are to be looked for, are common, while species of *Abies* are absent. In Europe *M. alpina* Juel has been cultured by means of *Saxifraga* caeoma on *Salix herbacea*, the common American host recorded for *M. arctica*. *M. arctica* is the older name, and the species to which it properly applies is a boreal form with aecia on Saxifragaceae, and entirely distinct from the more southern *M. americana* with aecia on *Abies*.

Pucciniastrum americanum (Farl.) comb. nov.

Pucciniastrum arcticum americanum Farl. Rhodora 10: 16. 1908.

This species differs from *Pucciniastrum arcticum* (Lagerh.) Tranz., with which it has been united, especially by the narrow, urceolate peridium, which is readily distinguished from the broad, low peridium of *P. arcticum*, even under a low power of the microscope. *P. arcticum* is a boreal species, chiefly known from northern Europe and Alaska. In Alaska it occurs on *Rubus stellatus* Smith and *R. Chamaemorus* L. Outside of Alaska only two American collections are known, one on *R. pubescens* Raf. (*R. triflorus* Richards.), from Grand Manan, New Brunswick, August, 1888, *K. Miyabe*, and one on *R. occidentalis* L., from Algona, Wisconsin, September, 1914, *B. O. Dodge*.

P. americanum is more southern and a much more abundant species. It ranges through the southern part of Canada from

British Columbia to Nova Scotia, and southward to Iowa and West Virginia. It is especially abundant in the northeastern United States on *Rubus strigosus* Michx., and less so on *R. occidentalis* L. It also occurs on *R. pubescens* Raf., and in the northwest on *R. melanolasius* Focke. The aecia for both *Pucciniastrum arcticum* and *P. americanum* are unknown.

Puccinia offuscata sp. nov.

II. Uredinia amphigenous, scattered, round or oval, 0.3–1 mm. long, rather tardily naked, pulverulent, dark cinnamon-brown, ruptured epidermis conspicuous; paraphyses intermixed with the spores, slightly clavate, 5–9 by 29–48 μ, the wall 1 μ thick, colorless, smooth; urediniospores broadly ellipsoid or broadly obovoid, 18–23 by 23–29 μ; wall cinnamon-brown, 1.5–2.5 μ thick, finely and closely echinulate, the pores 3 or 4, equatorial.

III. Telia hypophyllous, few, scattered, round, 0.1–0.3 mm. in diameter, rather tardily naked, compact, dark cinnamon-brown, ruptured epidermis conspicuous; teliospores clavate, 13–18 by 32–53 μ, rounded above, narrowed below, slightly constricted at septum; wall light golden-brown, 1–2 μ thick, slightly thickened at apex, 1–5 μ, smooth; pedicel up to one half length of spore, colorless.

On *Zornia bracteata* (Walt.) Gmel. (*Z. tetraphylla* Michx.), Braidentown, Florida, May 11, 1900, II, *S. M. Tracy 6583*.

On *Zornia diphylla* (L). Pers., Pinar del Rio, Cuba, April 23, 1903, II, iii, *J. A. Shafer 292;* Herradura, Cuba, September 30, 1904, II, iii, *C. F. Baker 2143* (type); same, November 26, 1917, II, *F. S. Earle 822;* Mayagüez, Porto Rico, March 7, 1916, II, *Whetzel & Olive 200;* Barcelonita, Porto Rico, April 6, 1916, II, *Whetzel & Olive 199*.

This species of rust has heretofore passed under the name of *Uredo Zorniae* or *Puccinia Zorniae*, names which properly apply to the Old World species on the same two hosts as listed above. The two species differ noticeably in both urediniospores and teliospores. The Old World species has urediniospores with two pores, or an occasional spore with three pores, and the teliospores are not so elongated, much constricted at septum, with the two cells nearly of the same size and shape, being globoid. An excellent description and an illustration from a photograph are given by McAlpine, Rusts of Australia, page 172, *pl. 10, f. 87*.

The teliospores of *P. offuscata* have been found only in the province of Pinar del Rio, Cuba. The earliest record was brought to light by Mr. Percy Wilson from a collection in the phanerogamic herbarium of the New York Botanical Garden, made by Shafer on a dry plateau, doubtless not far from Herradura. The teliospores, which have not yet been found in abundance, germinate *in situ* upon maturity. The same species occurs in the vicinity of Rio de Janeiro, Brazil (Hedwigia **38**: 257. 1899), and also in in northern Brazil (Hedwigia **43**: 161. 1904).

Puccinia senilis sp. nov.

II. Uredinia hypophyllous, scattered, 0.2–0.4 mm. in diameter, early naked, pulverulent, yellow, ruptured epidermis inconspicuous; urediniospores obovoid or broadly ellipsoid, 15–18 by 19–23 μ; wall light-yellow, 1 μ thick, sparsely echinulate, the pores very inconspicuous, apparently 3 or 4, equatorial.

III. Telia amphigenous, scattered, round, 0.1–0.3 mm. in diameter, early naked, pulverulent, chocolate-brown, ruptured epidermis inconspicuous; teliospores ellipsoid, 18–24 by 27–40 μ, rounded at both ends, somewhat constructed at septum; wall dark chestnut-brown, 1.5–2.5 μ thick, 5–7 μ over the germ-pores, often with a semihyaline cap over apex, coarsely and moderately verrucose; pedicel colorless, up to 50 μ long, tapering downward and roughened below, fragile.

On *Lippia myriocephala* Cham. & Schlecht., Laguna on Lake Amatitlan, Guatemala, January 20, 1906, II, III, *W. A. Kellerman 5451*. Only the one collection is known, of which the corresponding host collection, numbered 5209, was determined by John Donnell Smith. The material is not abundant but the rust appears distinct and unequivocal. If the wall of the teliospores were more evidently laminated, there could be no hesitancy in placing it under the genus *Prospodium*, although pycnia have not been detected. The species seems closely related to *Puccinia peruviana* Sydow, from western South America on *Lippia urticoides*.

Puccinia gulosa H. S. Jackson, sp. nov.

III. Telia caulicolous and petiolicolous, oval or elliptic, gregarious, frequently confluent along somewhat swollen stems and petioles for 1–2 cm., early naked, cinnamon-brown, pulverulent, ruptured epidermis noticeable; teliospores ellipsoid or oblong,

15–18 by 26–35 μ, rounded above and below, strongly constricted at septum; wall cinnamon-brown, 1.5–2 μ thick, with a small subhyaline umbo over the pore of the upper cell, 2.5–3 μ, finely but noticeably verrucose-rugose, best seen when dry; pedicel colorless, short, fragile, largely disappearing.

On *Polemonium pulcherrimum* Hook., Colby Mountains, above Muir Gorge, Yosemite National Park, California, 8500 feet altitude, August 6, 1919, *Mrs. Mary Strong Clemens 24*.

This species appears to be a short-cycle form, although no pycnia or germinating teliospores were found. It is similar to *P. Polemonii* Diet. & Holw., which is known by the type collection from Idaho, 1892, and one collection from southern Indiana, 1919. That species, however, has narrower, smooth spores, with a decidedly thickened apex, 4–6 μ. The sori of the latter are compact, and show abundant germination, while the sori of the new species are pulverulent, and show no germinating spores.

Puccinia proximella (Arth.) comb. nov.

Uredo proximella Arth. Mycologia **7**: 324. 1915.

Recently in studying this West Indian rust Dr. E. B. Mains discovered teliospores on the type collection made at Sabana Grande, Porto Rico, March 30, 1913, *F. L. Stevens 318*, and has drawn up the following description:

III. Telia hypophyllous, scattered, rather tardily naked, ruptured epidermis conspicuous; teliospores ellipsoid or oblong, 21–27 by 26–42 μ, rounded above and below, slightly constricted at septum; wall dark chestnut-brown, uniformly thick, 1.5–2 μ, moderately and distinctly verrucose; pedicel colorless.

Puccinia hiascens nom. nov.

Puccinia aucta Arth. & Holway; Arth. Am. Jour. Bot. **5**: 475. 1918. Not *P. aucta* Berk. & Müll. 1872.

The recent discovery that the name applied to this Guatemalan rust on *Saurauja* had previously been used for a very different Australian rust necessitates a change in the name.

Puccinia Heterisiae H. S. Jackson, nom. nov.

Puccinia aspera Diet. & Holway; Arth. Bull. Torrey Club **29**: 230. 1902. Not *P. aspera* Bon. 1869.

Dasyspora aspera Arth. Résult. Sci. Congr. Bot. Vienne 346. 1906.

Professor Jackson, who has been working upon the group to which this rust belongs, has suggested a change of the name, as the one under which it is now known he finds to be preoccupied. The rust is on *Heterisia Mertensiana* (Bong.) Small (*Saxifraga Mertensiana* Bong., *S. heterantha* Hook.), and beside the type collection from Mt. Adams (Mt. Paddo), Washington, at about 2000 meters altitude, is now known by an ample collection from the vicinity of Grinnell glacier, 1650–1950 meters altitude, Glacier National Park, Montana, July 31, 1919, *Paul C. Standley 16814*.

Uromyces imperfectus nom. nov.

Uredo Bauhiniae Berk. & Curt. Proc. Am. Acad. **4**: 126. 1860.
Uromyces Bauhiniae Vesterg. Ark. Bot. Stockh. 4^{15}: 21. 1905.
Not *U. Bauhiniae* P. Henn. 1895.

As the specific name for this species is preoccupied, a new name becomes necessary. Only two collections have been seen by the writer, one being the type collection from Nicaragua, and the other from Moneague, Jamaica, February 24, 1915, *E. W. D. Holway 231*, both showing only uredinia.

Uredo contraria sp. nov.

II. Uredinia hypophyllous, scattered, round, minute, 0.1–0.3 mm. in diameter, early naked, yellow, very pulverulent, ruptured epidermis inconspicuous; urediniospores oblong or obovate-oblong, 20–24 by 27–35 μ; wall colorless, 1.5–2 μ thick, finely and rather sparsely echinulate, the pores obscure.

On *Phacelia tanacetifolia* Benth., Carmel, California, April 15, 1919, *E. W. D. Holway*, July 4, and October 1, 1919, *Mrs. Joseph Clemens*.

This rust, in its gross appearance and even in the microscopic appearance of its spores, resembles species of *Pucciniastrum*, but careful sectioning of the sori shows them to be applanate, and without peridium or paraphyses. The spores are produced in abundance, and due to their bright yellow contents, make a considerable showing of yellow powder on the under side of the leaves. The species occurs among the sand dunes where *Pinus radiata* grows, and along the dusty roadsides of the region. It was watched

for a number of months by Professor Holway, and from January to October by Mrs. Clemens, but no other stage of development could be detected.

Uredo nitidula sp. nov.

II. Uredinia amphigenous, scattered, roundish or oblong, 0.3–0.7 mm. across, rather tardily naked, pulverulent, dark cinnamon-brown, ruptured epidermis conspicuous; urediniospores obovoid or ellipsoid, 18–24 by 24–29 μ; wall cinnamon-brown, 1.5–2 μ thick, moderately echinulate, the pores 2 or 3, equatorial.

On *Alternanthera philoxeroides* Griseb., Cahabon, Guatemala, October 27, 1877, *Von Türckheim*.

This collection is represented by a specimen in the cryptogamic herbarium of the New York Botanical Garden, where it is labelled "*Uredo? paranensis* Penningt." It is, however, noticeably different from the species indicated in having smaller spores with thinner walls.

Uredo laeticolor nom. nov.

Uredo Operculinae Arth. Mycologia **9**: 95. 1917. Not *U. Operculinae* Sydow, Phil. Jour. Sci. **8**: 476. 1913.

My attention has been called to the earlier use of the name which I gave to this convolulaceous rust from the West Indies. The name was used by the Sydows for a Philippine rust on *Operculina turpethum*, which appears from the description to have somewhat smaller and thicker walled spores, more inclined to be globoid, and paler in color.

Aecidium Ixorae sp. nov.

O. Pycnia epiphyllous, scattered unevenly over large discolored areas often 4–8 cm. across, punctiform, prominent, dark-brown, becoming whitish by age, subepidermal, flattened hemispherical, 150–200 μ in diameter, about half as high, with a flat hymenium; ostiolar filaments wanting.

I. Aecia hypophyllous, opposite the pycnia, scattered, deep-seated, cylindric, 0.2–0.3 mm. across; peridium colorless, the margin strongly recurved, lacerate; peridial cells rhombohedric, strongly imbricate, the exposed inner face about 16–19 μ across, in section much prolonged downward on outer side, the inner wall about 3 μ thick, verrucose, the outer wall about 2 μ thick, smooth; aeciospores globoid, small, 16–19 μ in diameter; wall colorless, 1 μ or less thick, finely verrucose, appearing smooth.

On *Ixora ferrea* (Jacq.) Benth. (*Siderodendron triflorum* Vahl), Bahia Honda, Cuba, October 28, 1919, *S. C. Bruner 1133*.

A very distinctive form, and especially remarkable in having hemispherical pycnia with flat hymenia, that are beneath the firm epidermis, opening at first by a minute central pore to discharge the pycniospores, and in all characters similar to pycnia heretofore known only as subcuticular. The large areas over which the original infection seems to spread, producing a brown, deadened appearance on both surfaces of the thick, leathery leaves, make the species an easy one to detect in the field. Mr. Bruner writes that the type locality is in a rather inaccessible district in the mountains, some six miles from the village of Bahia Honad.

Aecidium indecisum sp. nov.

O. Pycnia hypophyllous, scattered over all or large areas of the leaves among the aecia, conspicuous, honey-yellow, subepidermal, in section globoid, 80–110 μ in diameter; ostiolar filaments long.

I. Aecia hypophyllous, scattered from a diffused mycelium, cupulate, 0.3–0.5 mm. in diameter, projecting but slightly above the host tissue; peridium remaining somewhat incurved and covered by the host tissues, the margin erose; peridial cells in section oblong or rhomboidal, 16–26 by 30–40 μ, abutted, or slightly overlapping, the outer wall thick, 8–10 μ, transversely striate, smooth, the inner wall thinner, 3–6 μ, closely and rather finely verrucose; aeciospores ellipsoid or globoid, 16–19 by 21–26 μ; wall colorless, thin, 1–1.5 μ, closely and inconspicuously verrucose.

On *Ranunculus californicus* Benth., Berkeley, California, March 11, 1893 (Sydow, Ured. *900;* Barth. N. Am. Ured. *1303*), *W. C. Blasdale.*

This appears much like *Aecidium Ranunculi* Schw., the name under which it has been distributed, but differs in its much more robust development, the measurements in every way being greater. *A. Ranunculi* Schw. is known to be the aecial form of *Puccinia Eatoniae* Arth. on species of *Sphenopholis.* Both this rust and its telial host are only known from east of the Rocky Mountains. It may be assumed that the California aecia are heteroecious, and belong to some inconspicuous and rather evanescent grass rust, probably not yet reported.

There has probably been but one collection of this form made, although dates on the different packets in herbaria are not uniform. The date on the Sydow distribution is "31.5.1894," but a packet in the herbarium of the New York Botanical Garden, reads "March 31, 1894," so I assume that "5" is a misreading of "3." The Bartholomew distribution gives March 11, 1893. This material was received through Professor E. W. D. Holway, who obtained it from the collector. Possibly there were two collections made in consecutive years, but the appearance of the material does not warrant the assumption. I am using the material distributed by Bartholomew as the type.

Aecidium Mitellae Ellis & Ev., sp. nov.

O. Pycnia not seen.

I. Aecia hypophyllous, in crowded circular groups 2–3 mm. across; peridia cupulate, small; aeciospores globoid, or broadly ellipsoid, 15–18 by 18–26 μ; wall thin, 1 μ, colorless, minutely verrucose.

On *Mitella nuda* L., Shoal Point, Bay of Islands, Newfoundland, *Waghorne*.

The specimen from which this description is drawn is in the cryptogamic herbarium of the New York Botanical Garden, and consists of a single leaf bearing three groups of aecia. The specimen appears to have been sent to Mr. J. B. Ellis by Waghorne, although the collector's name is not written on the packet. The packet bears the doubtful date of "13.7.82," which possibly indicates that the material was secured on July 13, 1882. A note accompanies the specimen, reading, "This seems to be on various leaves and stems of this *Mitella;* I have only one leaf more." Whether this was written by Mr. Waghorne or Mr. Ellis is uncertain. There seems to be no doubt about the identity of the host, or the genuineness of the rust, so that the name given by Mr. Ellis and apparently not heretofore published, should be established. The form appears to be a heteroecious one.

Aecidium subsimulans Arthur & Mains, sp. nov.

O. Pycnia amphigenous, on brownish or reddish spots 2–5 mm. across, noticeable, cinnamon-brown, subepidermal, flattened-

globoid, 95–125 μ broad by 60–95 μ high; ostiolar filaments up to 125 μ long.

I. Aecia hypophyllous, crowded in spots with the pycnia, cylindric, 0.2–0.3 mm. wide, 0.5–1 mm. high; peridium white, the margin somewhat erect, erose; peridial cells rhomboidal, 19–26 by 32–45 μ, somewhat overlapping, the outer wall thick, 9–13 μ, transversely striate, smooth, the inner wall 4–6 μ thick, closely and rather coarsely verrucose; aeciospores globoid or ellipsoid, 19–23 by 23–29 μ; wall colorless, 1.5–2.5 μ thick, very closely and finely verrucose.

On *Salvia candicans* Mart. & Gall., hills about Tehuacan, State of Puebla, Mexico, 1895, *C. G. Pringle.*

On *Salvia Lemmoni* A. Gray, Carr Peak, Huachuca Mountains, Arizona, August 25, 1910, *L. N. Goodding 856* (type).

On *Salvia* sp., Sierra de Pachuca, State of Hidalgo, Mexico, July 20, 1905, *Rose, Painter & Rose 8792.*

This species somewhat resembles the aecia of *Puccinia caulicola* Tr. & Gall., as well as the Mexican *Aecidium zonatum* Sacc., but the walls both of the spores and of the peridial cells are much thicker. Dr. Mains, who has made a special study of the *Salvia* rusts, has joined me in deciding upon the status of this species.

Aecidium Betheli sp. nov.

O. Pycnia not seen.

I. Aecia hypophyllous, subepidermal, in small and crowded groups 1–3 mm. across, on a hemispherical, hypertrophied substratum, cupulate, small, 0.1–0.2 mm. in diameter; peridium low, erect, the margin erose; peridial cells readily falling apart, rhomboidal, 13–18 by 19–23 μ, strongly overlapping, the outer wall 7–9 μ thick, transversely striate, smooth, the inner wall 1 μ, evenly and noticeably verrucose; aeciospores globoid, small, 13–18 by 16–18 μ; wall colorless, thin, 1 μ or less, very finely and evenly verrucose.

On *Jussiaea californica* (S. Wats.) Jepson, Long Beach, California, August 15, 1916 (type), August 24, 1918, *E. Bethel.*

Found in abundance associated with *Puccinia canaliculata* (Schw.) Lagerh., on *Cyperus esculentus*, but probably not genetically connected, as neither the relationship of the host nor the structure of the aecia agrees with those of the known aecial stage for that species. The species is dedicated to the discoverer, who

is one of the most active and resourceful observers of the Uredinales among American botanists, and who has explored the Rocky Mountain and Pacific coast rust flora with unparalleled thoroughness.

Aecidium arctoum sp. nov.

O. Pycnia epiphyllous and to a less extent hypophyllous among the aecia, numerous, rather inconspicuous, small, subepidermal, in section globoid, 128–160 μ in diameter; ostiolar filaments prominent, up to 80 μ long.

I. Aecia hypophyllous, subepidermal, diffused on slightly paler spots 3–7 mm. across, cupulate, very small, 0.1–0.2 mm. in diameter; peridium delicate, erect or somewhat recurved, the margin erose or fimbriate; peridial cells rhomboidal, 16–19 by 28–32 μ, somewhat overlapping, the outer wall 1–1.5 μ thick, smooth, the inner wall 3–6 μ thick, moderately verrucose; aeciospores globoid, or some of them oblong, 21–26 by 23–29 μ; wall colorless, thin, 1–1.5 μ, minutely verrucose.

On *Elaeagnus angustifolia* L., Kulm, North Dakota, June 24, 1919, *J. F. Brenckle 1235*.

The form described here as a new species was found in considerable abundance on a hedge of the Eurasian oleaster in the town of Kulm. Dr. Brenckle, who submits the material, could find no rusted grass or sedge in the vicinity that seemed at all likely to serve as the alternate host, although it is undoubtedly a heteroecious species. The supposition that the rust could have been imported with the hedge plants can be dismissed as highly improbable, even aside from the fact that no aecial form on this group of hosts is known in the region where the host is native.

The spores are very much smaller than those of *Aecidium Allenii* Clint., on *Elaeagnus argentea* from North Dakota, as well as those of *A. Elaeagni* Diet. and *A. minoense* Sydow from Japan. There is a Japanese form on *Elaeagnus glabra* with spores of nearly the same size, but it has larger and firmer aecia, and other characteristics which distinguish it. In spite of the appearance of this form on an exotic shrub under conditions of cultivation, it seems most likely to be a native rust that has found a congenial host in this foreign plant.

Aecidium renatum sp. nov.

O. Pycnia epiphyllous, inconspicuous, subepidermal.

I. Aecia hypophyllous, subepidermal, thickly covering the surface of the leaf, short cylindric, 0.2–0.4 mm. in diameter; peridium erect, erose; peridial cells rhomboidal, 16–19 by 26–32 μ, strongly overlapping, the outer wall 3–5 μ thick, smooth, the inner wall 6–9 μ, prominently verrucose; aeciospores globoid, 19–23 by 21–24 μ; wall colorless, thin, 1 μ, closely and finely verrucose.

On *Polygala longa* Blake, Organ Mountains, New Mexico, August 29, 1894, *E. O. Wooton*.

This is a species similar in character and appearance to *Aecidium polygalinum* Peck on *Polygala Senega* from the northern United States, but has a more vigorous development, with larger aecia and aeciospores.

Aecidium arcularium sp. nov.

O. Pycnia epiphyllous, gregarious, minutely punctiform, inconspicuous, subepidermal, in section globoid or depressed-globoid, 100–130 μ broad by 90–100 μ high; ostiolar filaments up to 45 μ long.

I. Aecia hypophyllous and caulicolous, usually densely crowded in groups 4–10 mm. across; peridium cylindric, the margin erect, erose or deeply lacerate; peridial cells ellipsoid or oblong, angular, 21–29 by 27–40 μ, the cells overlapping, the outer wall 5–10 μ thick, transversely striate, smooth, the inner wall 2–5 μ thick, finely verrucose; aeciospores globoid or ellipsoid, 18–23 by 22–29 μ; wall colorless or pale cinnamon-brown, 1–1.5 μ thick, finely verrucose.

On *Coleosanthus grandiflorus* (Hook.) Kuntze (*Brickellia grandiflora* Nutt.), Beulah, New Mexico, 1889, *T. D. A. Cockerell;* Cloudcroft, New Mexico, September 16, 1903, *E. W. D. Holway;* Upper Miller Canyon, Huachuca Mountains, Arizona, August 14, 1909, Boulder Canyon, Colorado, August, 1914, *E. Bethel;* Ute Park, Colfax County, New Mexico, August 20, 1916, *Paul C. Standley 13383;* Grousemont, Platte Canyon, Colorado, July, 1918, *Mrs. Emily Arthur* (type); Idaho Springs, Colorado, August 7, 1919, *J. M. Bates 6987*.

A conspicuous species, usually occurring in abundance within limited area. It is sometimes associated with uredinia or telia of *Puccinia subdecora* Syd. & Holw., which for a time was supposed to be genetically connected with it. No suggestion has yet been made regarding the alternate stages.

Aecidium Liabi sp. nov.

O. Pycnia epiphyllous, somewhat loosely grouped on discolored areas, inconspicuous, dark-brown, subepidermal, ellipsoid, about 95 by 128 μ; ostiolar filaments short, about 45 μ.

I. Aecia hypophyllous, in groups up to 8 mm. in diameter, cupulate, 0.3–0.8 mm. in diameter; peridium pale-yellow, fragile; peridial cells rhomboidal, 19–23 by 35–55 μ, considerably overlapping, the outer wall 2–5 μ thick, smooth, the inner wall thicker, 5–7 μ, closely tuberculate-verrucose; aeciospores angularly globoid, 21–26 by 26–31 μ; wall colorless, 1.5–2.5 μ thick, closely and distinctly verrucose.

On *Liabum* sp., Jalapa, State of Veracruz, Mexico, September 2–4, 1910, *A. S. Hitchcock*.

Aecidium Batesii sp. nov.

O. Pycnia mostly epiphyllous, in groups 1–3 mm. in diameter, noticeable, subepidermal, chestnut- or chocolate-brown, flattened-globoid, 125–160 μ broad by 90–115 μ high; ostiolar filaments up to 95 μ long.

I. Aecia amphigenous, loosely grouped upon brownish spots 4–8 mm. across, cupulate, 0.5–0.8 mm. in diameter; peridium yellowish, the margin remaining for a time incurved, covered more or less by the epidermis, finally becoming recurved, lacerate; peridial cells oblong, 15–19 by 32–35 μ, slightly overlapping or abutted, the outer wall rather thick, 6–10 μ, transversely striate, smooth, the inner wall thinner, 3–4 μ, closely and finely verrucose; aeciospores angularly globoid, 19–23 by 24–27 μ; wall colorless, 1–1.5 μ thick, very closely and finely verrucose.

On *Rudbeckia hirta* L., Callaway, Nebraska, May 31, 1901, *J. M. Bates 1814½*.

This rust has something the appearance of the aecia of *Puccinia Stipae*, having large spores, in peridia that are partly covered for a time by the epidermis. It is named in honor of its discoverer, who has for many years been indefatigable in making the rust flora of Nebraska known, and whose field observations and collections from all parts of the state have been freely placed at the service of students of the Uredinales.

Aecidium Mesadeniae sp. nov.

O. Pycnia epiphyllous, few, crowded in small groups, 1–2 mm. across, inconspicuous, dark-brown, subepidermal, flattened-glo-

boid, 95–125 μ broad by 50–65 μ high; ostiolar filaments up to 40 μ long.

I. Aecia usually hypophyllous, crowded in groups 2–6 mm. across, cupulate, small, 0.1–0.3 mm. in diameter; peridium pale-yellow, the margin recurved, lacerate; peridial cells rhomboidal, 14–18 by 24–29 μ, overlapping, the outer wall 7–9 μ thick, transversely striate, smooth, the inner wall 2–3 μ thick, closely and rather finely verrucose; aeciospores globoid or ellipsoid, small, 12–16 by 15–19 μ; wall colorless, thin, 1 μ or less, closely and finely verrucose.

On *Mesadenia atriplicifolia* (L.) Raf. (*Cacalia atriplicifolia* L.), Manhattan, Kansas, May, 1886, *W. A. Kellerman* (Rab.-Wint.-Paz. Fungi Eur. *3833a*), same, June, 1886 (Ellis & Ev. N. Am. Fungi *1811*), Valley Park, Missouri, May, 1887 (*L. H. Pammel?*).

On *Mesadenia reniformis* (Muhl.) Raf. (*Cacalia reniformis* Muhl.), Somers, Wisconsin, June 3, 1894, *J. J. Davis* (type).

The type collection of this species was found in abundance in a small area where *Uromyces minimus* Davis, on *Muhlenbergia sylvatica*, also occurred, and at the time was thought might be its aecial stage (Bot. Gaz. **19**: 415. 1894; Bull. Lab. Nat. Hist. Univ. Iowa **5**: 315. 1902). That assumption has not been disproven but seems less probable now than at first.

Aecidium praecipuum sp. nov.

O. Pycnia amphigenous, in small groups about 2 mm. across, noticeable, pale-yellow becoming dark-brown, subepidermal, flattened-globoid, 110–130 μ broad by 80–95 μ high; ostiolar filaments up to 60 μ long.

I. Aecia hypophyllous, crowded on spots 2–10 mm. across, short cylindric, 0.3–0.5 mm. in diameter; peridium pale-yellow, the margin erect, erose; peridial cells irregularly oblong, 20–23 by 32–40 μ, considerably overlapping by a long projection of the outer wall, the outer wall thick, 9–11 μ, the inner wall thinner, 4–4.5 μ, closely and noticeably verrucose; aeciospores angularly globoid or ellipsoid, 16–19 by 19–26 μ; wall colorless, thick, 2.5–3.5 μ, very closely and inconspicuously verrucose.

On *Senecio praecox* DC., Mt. Montezuma, Sierra de Guadelupe, State of Mexico, Mexico, July 8, 1905, *Rose, Painter & Rose 8028;* Sierre de Pachuca, State of Hidalgo, Mexico, July 20, 1905, *Rose, Painter & Rose 8791* (type).

PURDUE UNIVERSITY,
LAFAYETTE, INDIANA

INDEX TO AMERICAN BOTANICAL LITERATURE

1916–1920

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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